

Nova V5579 Sgr 2008: Near-infrared studies during maximum and the early decline phase

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ABSTRACT

We present near-infrared spectroscopic and photometric observations of the nova V5579 Sgr during the maximum and early decline phase. The spectra follow the evolution of the nova from peak brightness when the lines had strong P Cygni profiles to a phase dominated by prominent emission lines. The spectra during the emission phase are dominated by strong H I lines from the Brackett and Paschen series, O I and C I lines. The spectra in the final stages of our observations show a rising continuum towards longer wavelengths indicating dust formation. Dust formation in V5579 Sgr is consistent with the presence of lines of elements with low ionization potentials like Na and Mg in the early spectra. The early presence of such lines had been earlier suggested by us to be potential indicators of dust formation later in the nova's development. We also discuss the possibility of using P Cygni profiles to probe the properties of the erupting white dwarf during the early outburst.

Key words: infrared: spectra - line : identification - stars : novae, cataclysmic variables - stars : individual (V5579 Sgr) - techniques : spectroscopic

1 INTRODUCTION

Nova V5579 Sgr was discovered on 2008 April 18.784 UT by Nishiyama and Kabashima (Nakano, Nishiyama & Kabashima 2008) at $V = 8.4$. Munari et al. (2008) reported a rapid and steady brightening of about 0.7 mag per day in the initial stages leading to the possibility of V5579 Sgr reaching naked eye visibility if the trend continued. However, the brightening lasted only for 5 days and V5579 Sgr reached a maximum brightness of $V_{max} = 6.65$ on 2008 April 23.541 UT as seen from its light curve (Fig. 1). The early optical spectrum taken during the pre-maximum phase by Fujii (2008) on 2008 April 19.82 UT showed hydrogen Balmer series absorption lines with $H\alpha$ having a prominent P Cygni profile and also several additional broad absorption lines indicating that V5579 Sgr is a classical nova. The infrared spectra taken by Russell et al. (2008) on 2008 May 9 showed lines of O I, N I, Ca II and exceptionally strong lines of C I. The full width at half maximum (FWHM) of the lines are approximately 1600 km s^{-1} . Even though the Fe II features were weak Russell et al. (2008) classify V5579 Sgr to be a Fe II type nova. The lines of neutral helium had not yet formed and the strongest lines were the O I lines that are fluorescently excited by $\text{Ly}\beta$. The infrared continuum showed

strong thermal emission from dust at a temperature of 1370 K. Subsequent infrared observations extending to $13.5 \mu\text{m}$ by Rudy et al. (2008) showed significant spectral changes like substantial decrease in the line strengths and pronounced absorption dip at the line centers. There was an increase in the dust emission and associated cooling of the dust temperature to 1080 K. The formation of dust can also be seen from the light curve. After reaching the maximum, V5579 Sgr followed a smooth and fast decline. This fading was interrupted, about 20 days after discovery, by a sharp decline seen in the AAVSO light curve consistent with the formation of dust in the nova ejecta as reported by Russell et al. (2008). A search in the Digitized Sky Survey (DSS) red image and U.K. Schmidt red plate by Dvorak (2008) did not reveal any object at the position of V5579 Sgr. With the limiting magnitude of these surveys being close to 20 magnitudes, V5579 Sgr is one of the large amplitude ($\Delta V = 13$ magnitudes) novae observed in recent years.

We present here near-infrared spectroscopic and photometric results of V5579 Sgr based on observations between 5 and 26 days after the discovery.

2 OBSERVATIONS

Near-IR observations were obtained using the 1.2m telescope of Mt. Abu Infrared Observatory from 2008 April 23 to 2008

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Table 1. A log of the spectroscopic observations of V5579 Sgr. The date of outburst has been assumed to be its detection date viz. 2008 Apr 18.784 UT

Date 2008 (UT)	Days since Outburst	Integration time (s)		
		<i>J</i>	<i>H</i>	<i>K</i>
Apr 23.949	5.165	20	40	40
Apr 26.966	8.182	40	40	20
May 3.947	15.163	30	30	60
May 4.977	16.193	30	30	60
May 8.972	20.188	45	45	60
May 13.914	25.13	200	100	

Table 2. A log of the *JHK* photometric observations of V5579 Sgr. The date of outburst has been assumed to be its detection date viz. 2008 Apr 18.784 UT

Date 2008 (UT)	Days since outburst	Magnitudes		
		<i>J</i>	<i>H</i>	<i>K</i>
Apr 23.988	5.204	4.58	4.47	4.16
May 1.894	13.11	5.58	5.14	4.90
May 8.926	20.142	6.19	5.96	4.69
May 14.919	26.135	6.85	5.47	4.09

May 15. The log of the spectroscopic and photometric observations are given in Table 1 and Table 2 respectively. The spectra were obtained at a resolution of ~ 1000 using a Near-Infrared Imager/Spectrometer with a 256×256 HgCdTe NICMOS3 array. In each of the *JHK* bands a set of spectra was taken with the nova off-set to two different positions along the slit (slit width 1 arc second). Spectral calibration was done using the OH sky lines that register with the stellar spectra. The spectra of the comparison star SAO 185320 were taken at similar airmass as that of V5579 Sgr to ensure that the ratioing process (nova spectrum divided by the standard star spectrum) removes the telluric features reliably. To avoid artificially generated emission lines in the ratioed spectrum, the H I absorption lines in the spectra of standard star were removed by interpolation before ratioing. The ratioed spectra were then multiplied by a blackbody curve corresponding to the standard star's effective temperature to yield the final spectra.

Photometry in the *JHK* bands was done in clear sky conditions using the NICMOS3 array in the imaging mode. Several frames, in 4 dithered positions, offset by ~ 30 arcsec were obtained in all the bands. The sky frames, which are subtracted from the nova frames, were generated by median combining the dithered frames. The star SAO 185779 located close to the nova was used for photometric calibration; the typical errors in the observed magnitudes are ± 0.03 . The data is reduced and analyzed using the *IRAF* package.

3 RESULTS

Before presenting the results proper, we estimate some useful parameters for V5579 Sgr.

3.1 The pre-maximum rise, outburst luminosity, reddening and distance

The light curves based on the *V* band data of AAVSO and *JHK* magnitudes from Mt. Abu are presented in Fig. 1. There is a good photometric coverage of the nova's rise to maximum which lasts for almost 5 days culminating in a peak brightness of $V_{max} = 6.65$. From a least square regression fit to the post maximum light curve we estimate t_2 to be 8 ± 0.5 d, making V5579 Sgr one of the fast Fe II class of novae in recent years. As mentioned earlier V5579 Sgr is also one of the large amplitude novae observed in recent years with $\Delta V = 13$ magnitudes. These observed values of the amplitude and t_2 for V5579 Sgr are consistent with its location in the amplitude versus decline rate plot for classical novae presented by Warner (2008). Using the maximum magnitude versus rate of decline (MMRD) relation of della Valle & Livio (1995), we determine the absolute magnitude of the nova to be $M_V = -8.8$. The reddening is derived using the intrinsic colors of novae at peak brightness, namely $(B - V) = 0.23 \pm 0.06$, as derived by van den Bergh & Younger (1987). We have used the optical photometry data from the AAVSO to calculate $E(B - V)$. The observed $(B - V) = 0.95 \pm 0.06$ results in $E(B - V) = 0.72 \pm 0.06$ and $A_V = 2.23 \pm 0.08$ for $R = 3.1$. Russell et al (2008) estimate $E(B - V) = 1.2$ using the O I lines in the spectra obtained on 2008 May 9 but remark that part of the reddening may be local to the nova as dust had already formed. Our observations, discussed in a later subsection, also clearly show the dust formation in V5579 Sgr. In their study of the spatial distribution of the interstellar extinction, Neckel & Klare (1980) have shown that close to the direction of V5579 Sgr, A_V steadily increases to a value of ~ 1.8 mag around 2 kpc and flattens after that. The moderate value of A_V estimated by us appears reasonable even though the nova is located close to the direction of Galactic Center. Based on the above we obtain a value of the distance $d = 4.4 \pm 0.2$ kpc to the nova.

3.2 Line identification, evolution and general characteristics of the *JHK* spectra

The *JHK* spectra are presented in Figs 2 to 4 respectively; line identification in graphical and tabular form are shown in Fig. 5 and Table 3 respectively. The infrared observations presented here cover all the phases with the first infrared spectra taken on 2008 April 23 very close to the visual maximum. These spectra are dominated by lines of hydrogen, neutral nitrogen and carbon and display deep P Cygni profiles. The emission components of all these lines have become stronger in the spectra taken on 2008 April 26 and by 2008 May 3 all the lines are seen in emission. The typical FWHM of the H I lines are 1500 km s^{-1} . A noticeable feature of these early spectra is the presence of lines due to Na I and Mg I. In the spectra taken on 2008 May 3 the Na I lines at $1.1381 \mu\text{m}$, $1.1404 \mu\text{m}$, $2.1452 \mu\text{m}$, $2.2056 \mu\text{m}$ and $2.2084 \mu\text{m}$ and Mg I lines at $1.1828 \mu\text{m}$, $1.5040 \mu\text{m}$, $1.5749 \mu\text{m}$ and $1.7109 \mu\text{m}$ are clearly seen. In an earlier study of V1280 Sco, Das et al. (2008) had suggested that the presence of spectral lines of low ionization species like Na I and Mg I in the early spectra are indicators of low temperature zones conducive to dust formation in the nova ejecta and this is very well borne out in the case of V5579 Sgr. We would like to point

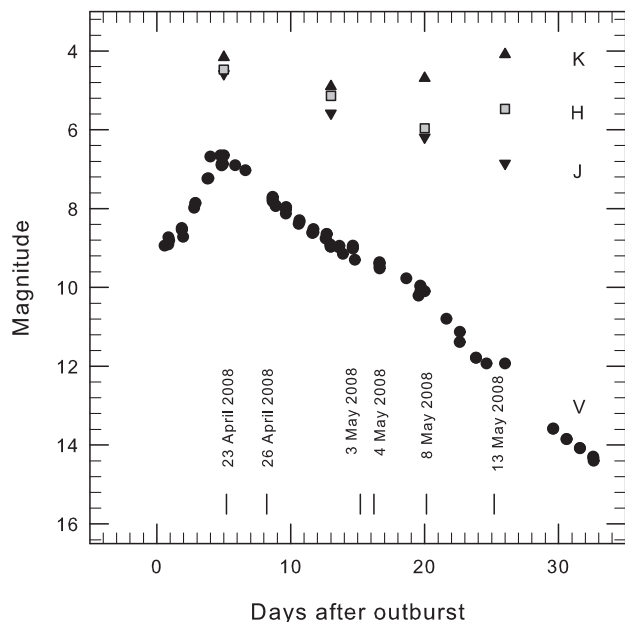


Figure 1. The V band lightcurve of V5579 Sgr from AAVSO data. The days of spectroscopic observations are indicated by dashes below. The Mt Abu *JHK* photometric data is also shown.

out the presence of a large number of strong lines of neutral carbon. These are typical of Fe II type nova as seen in the case of V1280 Sco (Das et al. 2008) and V2615 Oph (Das et al. 2009). The rising continuum is seen in the spectra taken on 2008 May 8 indicating formation of significant amount of dust in the nova ejecta. The dust continuum has started dominating on 2008 May 13.

From the K band spectra we do not find CO emission bands in the first overtone. However it is possible that such emission may be weakly present but below detection levels. It is thus useful to try and set an upper limit on the strength of the CO emission and hence on the CO mass. An upper limit can be set by computing a model spectrum for the CO emission and using the criterion that CO emission should be discernible if the calculated model strengths of the CO bands are at least 3σ times the value of the continuum noise in the CO band region ($2.29 - 2.4 \mu\text{m}$). The model CO spectrum has been computed along the same lines as done for the nova V2615 Oph, where CO was strongly detected, and which is described in details in Das et al. (2009). The model calculations were done for the temperature range of 2500 K to 4200 K corresponding to the observed values in case of novae where CO has been detected and modeled (first overtone detections have been made in V2274 Cyg - Rudy et al. 2003; NQ Vul - Ferland et al. 1979; V842 Cen - Hyland & McGregor 1989, Wichmann et al. 1990, 1991; V705 Cas - Evans et al. 1996; V1419 Aql - Lynch et al. 1995; V2615 Oph - Das et al. 2009; V496 Sct - Rudy et al. 2009, Raj et al. 2009). A value of $3 - 5 \times 10^{-9} M_{\odot}$ is obtained for the upper limit of M_{CO} using a distance of 4.4 kpc to the nova.

Theoretically, the detailed modeling of Pontefract and Rawlings (2004) for molecule formation and destruction in nova winds, predicts that CO should form early after the outburst, remain constant in strength for ~ 15 days thereafter and then get rapidly destroyed. Fairly consistent with this picture, most of the CO detections outlined above have

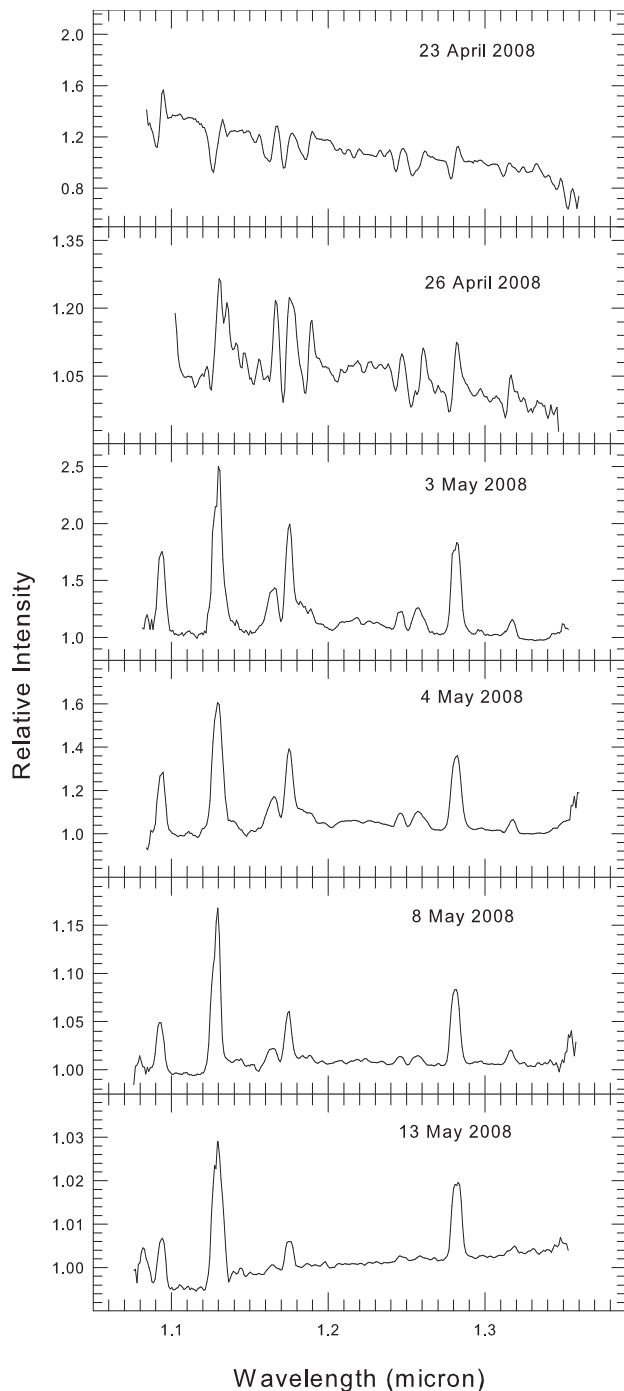


Figure 2. The *J* band spectra of V5579 Sgr are shown at different epochs. The relative intensity is normalized to unity at $1.25 \mu\text{m}$

indeed been reported early after the outburst (see Das et al. 2009 for a detailed discussion). Thus, in the present case too, CO emission could have been expected. Its absence indicates that it either is present but below detection levels or that it did not form for reasons which are not clearly understood.

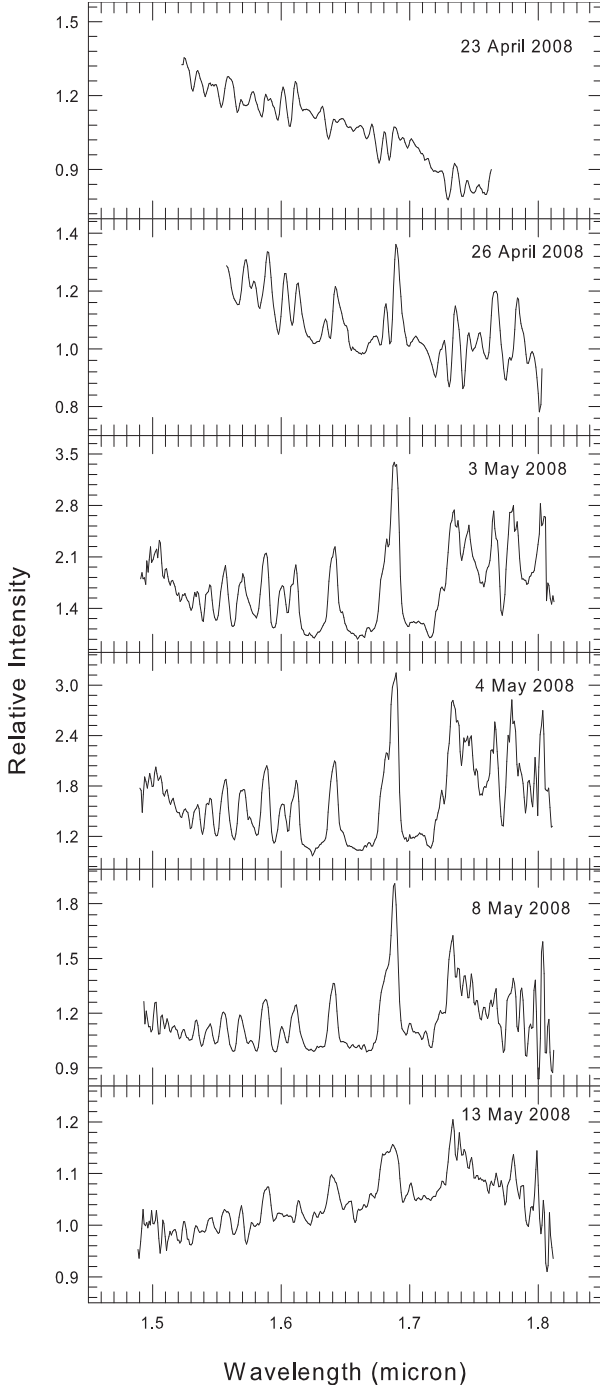


Figure 3. The *H* band spectra of V5579 Sgr are shown at different epochs. The relative intensity is normalized to unity at 1.65 μm

3.3 Fireball phase

As noted earlier, V5579 Sgr showed pre-maximum brightening. After its discovery on 2008 April 18.784 UT by Nishiyama & Kabashima (Nakano 2008) at 8.4 mag, it brightened by nearly 1.8 mag over next five days to reach maximum of $V = 6.65$ mag on 2008 April 23.541 UT. This pre-maximum rise is well observed at optical wavebands. Our first near-IR photometric observations are available for 2008 April 23.988 UT close to the optical maximum. We

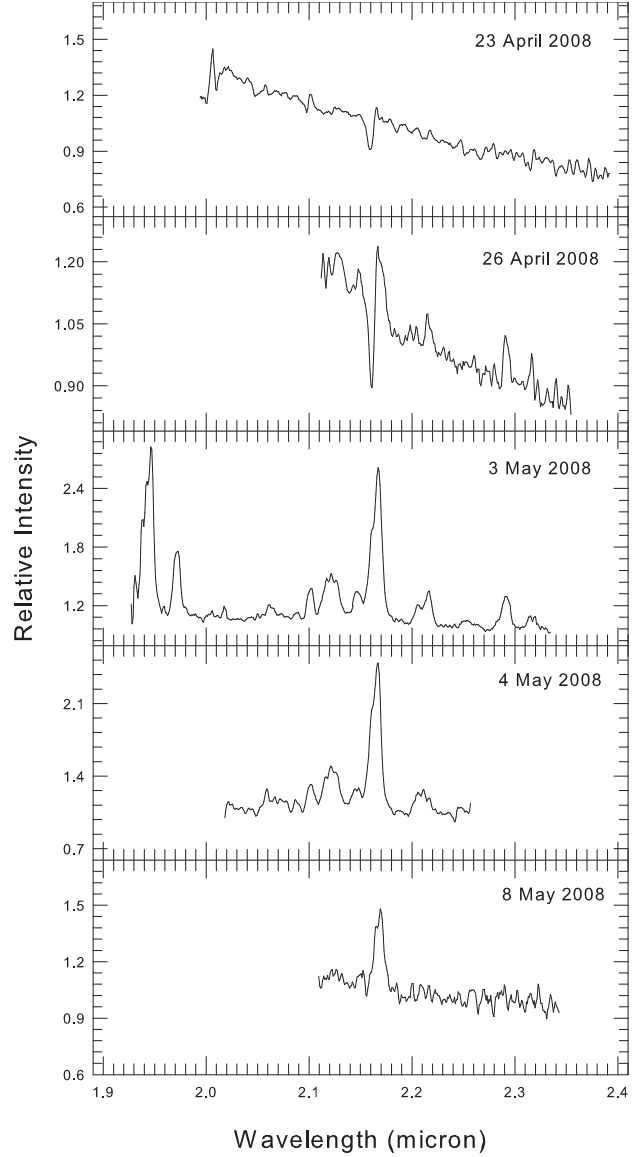


Figure 4. The *K* band spectra of V5579 Sgr are shown at different epochs. The relative intensity is normalized to unity at 2.2 μm

have studied the fireball phase by obtaining spectral energy distribution (SED) covering the optical and near-IR region. The following optical magnitudes $B=7.6$, $V=6.87$, $R_C=6.23$ and $I_C=5.55$ at maximum brightness from AAVSO along with the present *JHK* magnitudes of 2008 April 23.988 UT were used in deriving the SED. The observed magnitudes were corrected for extinction using Koornneef's (1983) relations and $A_V=2.23$ mag. From a blackbody fit to the SED shown in top panel of Fig. 6, we obtain a formal temperature of $T_{bb} = 8900 \pm 400$ K which is consistent with the A to F spectral type for the pseudo-photospheres displayed by novae at outburst (Gehrz 1988). However, this temperature T_{bb} estimate is likely to have additional errors as all the observed flux values used in the fit lie on the Rayleigh-Jeans part of the spectral energy distribution. Further, the *B* band flux value is also susceptible to significant errors since it has the largest interstellar extinction correction. The blackbody

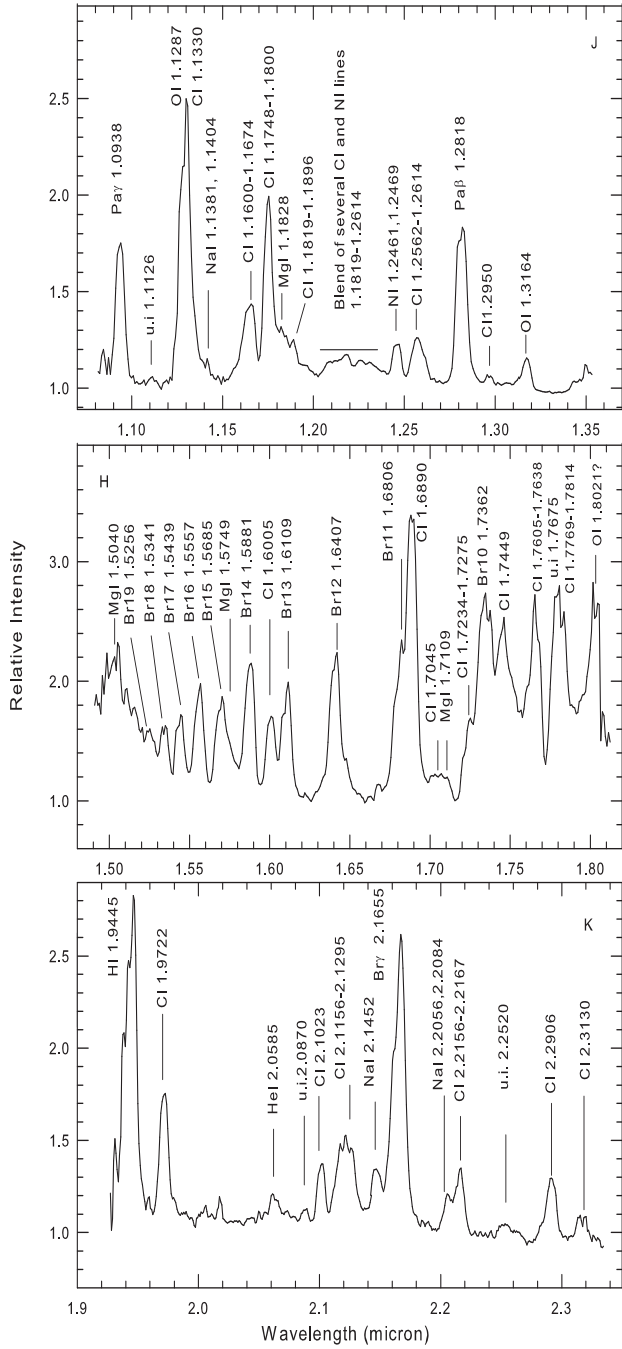


Figure 5. The line identification is shown for the spectra of 2008 May 3 in the *JHK* bands as given in Table 3.

angular diameter θ_{bb} in arcseconds is calculated using the relation given by Ney & Hatfield (1978), namely,

$$\theta_{bb} = 2.0 \times 10^{11} (\lambda F_{\lambda})_{max}^{1/2} \times T_{bb}^{-2} \quad (1)$$

where $(\lambda F_{\lambda})_{max}$ is in W cm^{-2} and T_{bb} is in Kelvin. From the model blackbody fit of 8900 K shown in Fig. 6 (upper panel), we find $(\lambda F_{\lambda})_{max} = 3.64 \times 10^{-14} \text{ W cm}^{-2}$. We accordingly obtain a value of ~ 0.5 milliarcsec for the angular diameter. This value for the angular diameter can be used to estimate the distance to the nova by invoking constant expansion rate for the ejecta and the relation given by Gehrz (2008), namely,

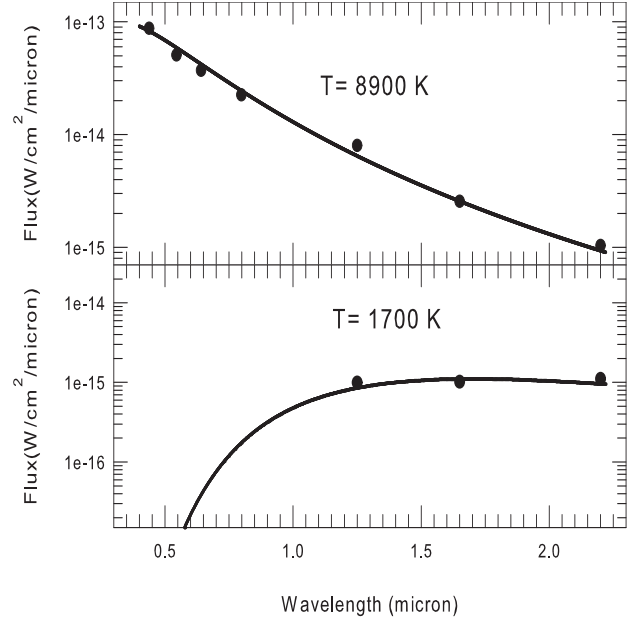


Figure 6. The top panel shows spectral energy distribution for the fireball phase data of April 23.988 UT with blackbody temperature fit of 8900 K. The bottom panel shows a similar fit for the data of May 14.919 UT with blackbody temperature fit of 1700 K after dust formation.

$$d = 1.15 \times 10^{-3} (V_{ej}) t / \theta_{bb} \quad (2)$$

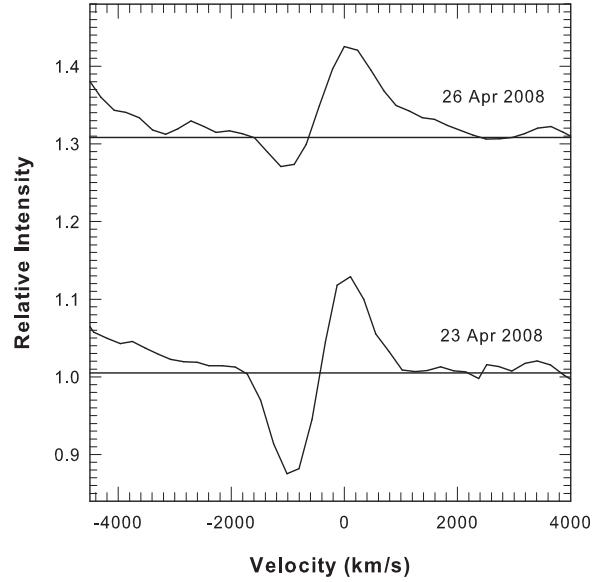
where d is in kpc, V_{ej} in km s^{-1} , t in days since outburst began and θ_{bb} in milliarcsec. Taking a value of 1500 km s^{-1} , the typical FWHM of H I lines for V_{ej} and $t = 5 \text{ d}$ corresponding to the epoch of optical maximum we get $d = 17.3 \text{ kpc}$ which is four times larger than the estimate done in section 3.1 using the MMRD relation. The reason for this discrepancy is not clear. A likely reason is that the pseudo photosphere behaves as a grey body with reduced emissivity in the fireball phase. The estimate of θ_{bb} will always be a lower limit since it is applicable for a blackbody (Ney & Hatfield 1978; Gehrz et al. 1980). For a grey body, the observed angular size can be larger, since the right hand side of equation 1 should be divided by $\epsilon^{1/2}$, where ϵ the emissivity has a value less than unity. A similar discrepancy was noticed by Das et al. (2008) in the case of V1280 Sco, where the blackbody angular diameters were smaller by a factor of three than the values derived from the interferometric measurements. It should be noted that the value of t is likely to have an error due to the uncertainty in the determination of the start of the outburst. For V5579 Sgr, Yamaoka (2008) and Liller (2008) report that no object brighter than 11.5 and 11.0 mag respectively was seen on their petrol images taken around 2008 April 15.743 UT and 2008 April 16.22 UT. Thus our estimate of t is likely to have an error of ~ 2 days which worsens slightly more the discrepancy between the distances determined using the MMRD and the blackbody angular diameter relations.

3.4 Dust formation and ejecta mass estimate

The light curve showed a sharp fall about 15 days after the visual maximum indicating onset of dust formation. The

Table 3. A list of the lines identified from the *JHK* spectra shown in Figure 5. The additional lines contributing to the identified lines are listed and the unidentified lines are mentioned as u.i.

Wavelength (μm)	Species	Other contributing lines and remarks
1.0938	Pa γ	
1.1126	u.i	Fe II ?
1.1287	O I	
1.1330	C I	
1.1381	Na I	C I 1.1373
1.1404	Na I	C I 1.1415
1.1600-1.1674	C I	strongest lines at 1.1653, 1.1659, 1.16696
1.1746-1.1800	C I	strongest lines at 1.1748, 1.1753, 1.1755
1.1828	Mg I	
1.1819-1.2614	several C I and N I	strongest lines at 1.1880, 1.1896
1.2461, 1.2469	N I	blended with O I 1.2464
1.2562, 1.2569	C I	blended with O I 1.2570
1.2818	Pa β	
1.2950	C I	
1.3164	O I	
1.5040	Mg I	blended with Mg I 1.5025, 1.5048
1.5256	Br 19	
1.5341	Br 18	
1.5439	Br 17	
1.5557	Br 16	
1.5701	Br 15	
1.5749	Mg I	blended with Mg I 1.5741, 1.5766, C I 1.5788
1.5881	Br 14	blended with C I 1.5853
1.6005	C I	
1.6109	Br 13	
1.6407	Br 12	
1.6806	Br 11	
1.6890	C I	
1.7045	C I	
1.7109	Mg I	
1.7234-1.7275	C I	several C I lines
1.7362	Br 10	affected by C I 1.7339 line
1.7449	C I	
1.7605-1.7638	C I	
1.7675	u.i	
1.7769-1.7814	C I	
1.8021	O I ?	
1.9445	H I	
1.9722	C I	
2.0585	He I	
2.0870	u.i	
2.1023	C I	
2.1156-2.1295	C I	
2.1452	Na I	
2.1655	Br γ	
2.2056, 2.2084	Na I	
2.2156-2.2167	C I	
2.2520	u.i	
2.2906	C I	
2.3130	C I	

**Figure 7.** The time evolution of *Pa* β 1.2818 μm line showing the evolution of the P Cygni feature. For more details see section 3.5.

thermal emission from the dust contributes to the near-IR bands and one expects a brightening at these wavelengths. The present near-IR photometric observations presented in Fig. 1 clearly show the onset of dust formation associated with the fall in the visual light curve around 2008 May 8 accompanied simultaneously thereafter by a steady increase in the near-IR magnitudes, especially in the *K* band. The SED of the dust component in the ejecta is constructed using the observed *JHK* magnitudes on 2008 May 14.919 UT and shown in the lower panel Fig. 6. The contribution of the thermal emission from the dust is seen increasing upto the *K* band indicating that it may peak at even longer wavelengths. We estimate a value of 1700 ± 200 K for the temperature of the dust shell. However, this estimate of temperature for the dust shell has large uncertainty as observations in only three wavelengths are used in fitting the SED of which the dust is contributing mostly in the *K* band. Russell et al (2008) have estimated the dust shell temperature to be 1370 K based on the observations spanning the wavelength range upto 5.2 μm . The likely reason for the higher value for the dust temperature derived by us is the restricted spectral coverage extending upto *K* band only that may have emphasized the contribution at shorter wavelengths.

The mass of the dust shell can be calculated from the thermal component of the SED of 2008 May 14 UT shown in Fig. 6. Woodward et al. (1993) have given the expression for the mass of the dust shell as $M_{dust} = 1.1 \times 10^6 (\lambda F_{\lambda})_{max} d^2 / T_{dust}^6$. In the expression above, mass of the dust shell M_{dust} is in units of M_{\odot} , $(\lambda F_{\lambda})_{max}$ is in W cm^{-2} measured at peak of the SED, the black-body temperature of the dust shell T_{dust} is in units of 10^3 K, and the distance to the nova d is in kpc. It is assumed that the dust is composed of carbon particles of size less than 1 μm with a density of 2.25 gm cm^{-3} . The early dust formation, high dust temperature and SED in the near-infrared that resembles black-body in the case of V5579 Sgr are indicative of presence of carbon grains in the dust shell (Clayton & Wickramasinghe 1976).

In addition the occurrence of strong carbon spectral features in the observed spectra indicate that our assumption that the dust is made up of carbon/graphite is reasonable. We obtain $M_{dust} = 2.12 \times 10^{-9} M_{\odot}$ for 2008 May 14 taking the observed parameters of $(\lambda F_{\lambda})_{max} = 2.42 \times 10^{-15} \text{ W cm}^{-2}$, $T_{dust} = 1.7 \times 10^3 \text{ K}$ and $d = 4.4 \text{ kpc}$. The observed ratio for the M_{gas} to M_{dust} range from 1.8×10^2 for LW Ser that formed optically thick dust shell (Gehrz et al. 1980) to 2.5×10^4 for V1425 Aql that formed optically thin dust shell (Mason et al. 1996). Taking a canonical value of 200 for the gas to dust ratio, we get $\sim 4.2 \times 10^{-7} M_{\odot}$ for the gaseous component of the ejecta. This value is smaller than the typically observed value of 10^{-4} to $10^{-6} M_{\odot}$ in novae. One definite reason for the dust mass being underestimated is that our SED is based on data extending upto only $2.2 \mu\text{m}$ and certainly neglects contribution from dust emission at longer wavelengths. In this process we are overestimating the derived dust temperature considerably as is evident from Russell et al. (2008) who get $T_{dust} = 1370 \text{ K}$ on 2008 May 9, five days before the date being considered in this analysis, which further cools down quickly to 1070 K by 2008 May 22 (Rudy et al. 2008). The formulation used for the dust mass estimate is very sensitive to T_{dust} . Further, since the Rudy et al. (2008) and Russell et al. (2008) reports show that the dust emission peaks at longer wavelengths, we are also underestimating $(\lambda F_{\lambda})_{max}$. Correct use of both T_{dust} and $(\lambda F_{\lambda})_{max}$ values should considerably enhance the dust mass estimate made here.

We have alternatively explored the possibility of estimating the ejecta mass using recombination line analysis of H I. However, we find that the strengths of these lines, relative to each other, deviate considerably from Case B values on all epochs indicating that the lines are optically thick. Hence we are unable to estimate the ejecta mass from recombination analysis.

3.5 A discussion of the P Cygni phase

We qualitatively discuss the P Cygni profiles seen around maximum light as they can help estimate the radius of the white dwarf's (WD) photosphere (r_{ph}) at this epoch. Kato & Hachisu (1994) have shown from theoretical considerations of the photospheric optical depth that $r_{ph} \geq 100 R_{\odot}$ at maximum. This is a substantial increase by a factor of almost 10^4 in the WD's radius between quiescence to maximum. Subsequent refinements in their modeling of novae light curves reaffirm that after the thermonuclear runaway sets in on a mass-accreting WD, its envelope expands greatly to $r_{ph} \geq 100 R_{sun}$ (Hachisu & Kato, 2001; Hachisu & Kato, 2006) the evolution of r_{ph} with time is illustrated diagrammatically in the above works. It is desirable to have observational confirmation for such estimates of r_{ph} and P Cygni profiles may provide an assessment of this physical parameter.

The generic formation of P Cygni profiles, following Lamers & Cassinelli (1999), can be understood by considering a spherical symmetric outflowing wind (in our case the mass loss from the nova outburst) in which the velocity necessarily increases outwards i.e., the wind is accelerated outwards till it reaches a terminal velocity. To the outside observer, it is the matter in the form of a tube in front of the stellar disc which scatters light from the continuum of the star that is responsible for the absorption component

of the P Cygni profile (see Fig. 2.4 in Lamers & Cassinelli (1999)). The ratio of the strength of the emission and absorption components of the P Cygni profile depends on the size r_w of the wind region (i.e., size of the ejected material) relative to the size of the star. If the star is large compared to the size of the wind region the emission will be smaller than the absorption. When the wind region is large compared to the star's size we expect emission to dominate - this can be seen geometrically as the volume of the emitting gas becomes much larger than the volume causing the absorption component. Observationally consistent with this scenario, it is known that prominent P Cygni profiles in a nova outburst are inevitably seen and reported at maximum light and on one or two days following it. At such an epoch, it is therefore reasonable to use an approximation that the wind region size r_w is of the order of the stellar size r_{ph} . Since the wind region size r_w can be approximated kinematically ($r_w \sim v_{mean} \times t$, v_{mean} = mean velocity of ejecta, t = time after outburst), a qualitative estimate can be made of r_{ph} . This could be used as the rationale in estimating r_{ph} . As the ejected matter (the wind region) keeps expanding to larger sizes at later times following the maximum, the emission component strengthens and finally begins to dominate. This expected behaviour is reasonably in accordance with the early P Cygni profiles seen in V5579 Sgr as shown in Fig. 7.

A simplistic order-of-magnitude estimate for r_{ph} may be obtained in the following way. Let a typical velocity of $v_{mean} \sim 1000 \text{ km s}^{-1}$ for the nova ejecta be assumed. Velocities in nova ejecta can range from few hundreds to few thousands of km s^{-1} and $v_{mean} = 1000 \text{ km s}^{-1}$ is a fairly representative value. For our choice of v_{mean} , and taking $t = 1 \text{ d}$ as the typical timescale when prominent P Cygni profiles are generally seen, the value of $r_w \sim 120 R_{sun}$ encouragingly matches that expected for r_{ph} . However, we emphasize that this is purely a qualitative estimate. We hope to undertake a detailed modelling, which takes into account a realistic wind-velocity law in the ejecta, to try and reproduce observed P Cygni profiles in novae and their evolution with time.

4 SUMMARY

We have presented near-infrared spectroscopy and photometry of nova V5579 Sgr which erupted on 2008 April 19. From the optical lightcurve, the distance to the nova is estimated to be $4.4 \pm 0.2 \text{ kpc}$. The infrared spectra indicate that the nova is of the Fe II class. Evidence is seen from the *JHK* photometry and spectra for the formation of dust in the nova in mid-May 2008. In this context, the presence of emission lines from low ionization species like Na and Mg in the early spectra and subsequent formation of the dust supports the predictive property of these lines as indicators of dust formation as proposed by Das et al (2008). It may be noted that V5579 Sgr is one of the few fast Fe II class of novae ($t_2 = 8 \text{ d}$) that formed dust. We have indicated the possible usefulness of the P Cygni profiles seen in the novae spectra around maximum brightness to study the physical parameters related to the central white dwarf.

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